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YAM PRODUCTION AND ITS DETERMINANTS IN NIGERIA

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Abstract
There is global food insecurity which could be attributed to poor performance of farmers in the developing countries. Ironically, Nigerian farmers are poor and the most food insecure. Yam contributes to wealth and food security of Nigeria. Notwithstanding, yam farmers in Nigeria are performing poorly. It is crucial to improve the performance of yam farmers for food security and poverty alleviation in the country. This paper investigates yam production in Nigeria and how it can be improved. The aim of this paper is to describe and compare yam production and its determinants in Nigeria. This research employed a multistage sampling technique in eliciting cross-sectional data from 360 farmers in Nigeria in 2013. Stochastic frontier and metafrontier analyses were used to determine factors affecting yam production. Descriptive statistics were used to discuss the Status of yam farmers and yam production. ANOVA was performed to determine similarities in variables between States. The result shows that yam production in Nigeria is dominated by middle-aged educated male farmers with large households and small farms. They have limited access to fund and extension services, and use insufficient inputs for yam production. The investigation also proves that farm size, labour and planting material are increasing factors of production. This research makes these three key recommendations for yam production in Nigeria. Government subsidy on inputs and the adoption of appropriate input dissemination strategies to ensure that inputs reach yam farmers in good condition and time; the use of labour-saving devices; and the development of alternative farming systems for yam to encourage mechanization.

Keywords: Yam production, stochastic frontier production function, metafrontier analysis

Introduction

Yam contributes to wealth and food security of the people of sub-Saharan Africa but it yield has been declining (Ikeh *et al*., 2012). Yam is a highly prized crop in Nigeria. It is nutritionally superior to other comparable crops (Wanasundera and Ravindran, 1994) and a major employer of labour in Nigeria (Verter and Becvarova, 2015). Nigeria is the leading yam-producing country (Food and Agricultural organization (FAO), 2015). Although yam production in Nigeria has risen over time (FAO, 2012), there is decreasing yield and low annual growth rate of yam production in Nigeria. Increased yam production is due to expansion of land area under yam cultivation (Amaefula, 2018).

Yams are one of the most expensive crops to produce, National Bureau of Statistics (NBS) (undated). Yam production is expensive and labour-intensive in Nigeria. Labour constitutes approximately 40% of the total cost of yam production (Okoro, 2008). Nevertheless, yam cultivation is profitable (Amaefula *et al*., 2018) and demand high (IITA, 2009a). High demand for yam has contributed to increase in its price, making it too expensive for many. There is an urgent need to investigate ways of boosting yam production and reducing the cost of yam production to make yams available to consumers at affordable price. Earlier studies that determined factors of yam production in Nigeria focused on a particular State or agroecological / geopolitical zones. For instance, Ike and Inoni (2006) investigated the determinants of yam production and economic efficiency of small-holder farmers in Southeastern Nigeria. They reported that labour and material inputs are factors affecting yam output. Shehu *et al*. (2010) examined the determinants of yam production and technical efficiency among yam farmers in Benue State. They observed that land, seed yam, family labour and fertilizer were the major factors influencing changes in yam output in the State. To the best of my knowledge, none of the earlier studies in Nigeria has compared yam production in major yam-producing agroecological zones. This present research investigates yam production and its determinants in

major yam-producing States, which are located in different agroecological / geopolitical zones of Nigeria. The objectives of this research are to ascertain the status of yam farmers in Nigeria; determine the production of yam in Nigeria and factors affecting it. This research will enable increased food production; thereby leading to a more profitability yam production and improved wellbeing of farmers in Nigeria.

Methodology

This study was conducted in Nigeria which is located in West Africa. Geographically, Nigeria lies between longitude $3^0$and 14^0 E and latitude 4^0 and 14^0N (NBS, 2010). A multi-stage sampling technique was adopted in extracting cross-sectional data from yam farmers in top yam-producing areas of Nigeria. Figure 1 displays the top yam-producing States of Nigeria. They include Nassarawa, Benue, Taraba, Enugu, Niger, Kaduna, Cross River, Ondo, Ekiti and Kogi. Benue has the highest yam production than the other States while Kogi has the lowest. The first stage involved a random selection of three yam producing agro-ecological zones. The second stage involved a random selection of three States producing a minimum of 1.2 million metric tonnes of yam per annum from the zones. The States were Benue, Enugu and Ondo which are located in guinea savannah, tropical rainforest with derived savannah, and low land rainforest with sub savannah and agro-ecological zones of Nigeria respectively. The third stage involved random selection of two major yam-producing Local Government Areas (LGAs) from each State (the extension agents in each State assisted in identifying the leading yam-producing LGAs). The LGAs selected were Buruku and Katsina-Ala in Benue State, Nkanu-East and Uzo Uwani in Enugu State, and Owo and Ose in Ondo State. A minimum of sixty farmers were randomly selected from each LGA. Data were collected from a total of 411 respondents by using a well-structured questionnaire. Information from 360 respondents were used for this investigation, questionnaire with incomplete responses were discarded. Descriptive statistics and econometrics model were used for the purpose of this study. Descriptive statistics (obtained from SPSS) such as mean and percentage were used to discuss the characteristics of yam farmers and yam production. ANOVA was performed to ascertain similarities in variables between States. Frontier 4.1c software was used to estimate the production function for yam in Nigeria. Input and output data of the farms were used to estimate maximum likelihood (MLE). MLE of translog production function (automatically generated from Frontier 4.1c software) was used to determine factors influencing production of yam. Translog production function for estimation of production factors is specified as:

$$\text{Log}Y_i = b_0 + \sum_{k=1}^{5} b_k \log X_{ik} + 0.5\sum_{k=1}^{5} \sum_{m=1}^{5} b_{km} \log X_{ik} \log X_{im} + V_i - u_i$$

where Y = output of yam, X_{ik} are vectors of inputs where X_1 = land area in hectares, X_2 = labour in man-days , X_3= fertilizer used in kg, X_4 = seed yam used in kg, X_5 = depreciated cost of capital inputs, v_i= random errors not under the control of the farmer, u_i captures technical inefficiency relative to stochastic frontier, and b_0 and b_k are estimated parameters. ANOVA was used to test the hypothesis that the mean regional output, production inputs, and farmer characteristics were significantly different. The hypotheses that production inputs determine yam output was tested with t-test. The t-value was generated from Frontier 4.1c software. The null hypothesis (H_0) that at least one of the parameters is equal to zero is rejected when the t-value is greater than t- tabulated (from t-table) at 10%, 5% or 1%. This analysis used information obtained from the three sampled States to represent the entire country. From the sampling technique used for this research, cumulative data of the States is a good representative of the country. Each yam-producing State had equal chance of being selected.

Results and Discussion

Socioeconomic profile of yam farmers in Nigeria

Nigerian yam farmers are mostly middle-aged males with large families. On average, they have secondary education. The majority of the farmers in Nigeria are experienced in yam farming. However, they have small farms and limited contact with extension agents. The socioeconomic characteristics of yam farmers in Nigeria are presented in Table 1. The majority of Nigerian yam farmers are in their active age. Table 1 discloses that an average yam farmer in Nigeria was 47 years old. The mean age of yam farmers in Enugu was markedly different from those in other States. There were younger farmers in Ondo compared to other States. The average age of yam farmers in Benue and Ondo were similar. Yam production in Nigeria is dominated my males (Table 1). This supports Omojola (2014) in Osun State and Nlerun (2006) in Rivers State both in Nigeria, who reported that males were more involved in yam production in Osun and River States respectively. Eighty-five percent of Nigerian yam farmers were male (Table 1). This is in line with Izekor and Alufohia (2014) who observed that 83.33% of yam farmers in Edo State were male. More males were engaged in yam production in Benue State. Enugu had a lower number of males who were involved in yam production. There was no significant difference in male involvement in yam farming between Ondo and the other States. Generally, females did not participate actively in yam production in Nigeria. Only 15% of the respondents were female. More females were involved in yam farming in Enugu than in other States. Benue had the lowest population of female who were involved in yam production. The unequal gender involvement in yam production in Nigeria could be due to the laboriousness of yam production which requires more energetic men (Omojola, 2014). Nigerian yam farmers have large households. An average Nigerian yam farmer had a household size of eight members. Benue had the largest household size while Ondo had the lowest. The

household size for Ondo and Enugu was similar. Most Nigerian yam farmers have some form of education (Table 1). The majority of Nigerian farmers had secondary education. An average yam farmer had 9.3 years of education (Table 1). This is in line with Mgbada *et al*. (2016) who noted that the mean level of education for Nigerian farmers was 9.4 years. More educated farmers were involved in yam production in Ondo than in other States. Ondo and Benue States had reached a similar level of education. This analysis reveals that farming is the primary occupation of most Nigerian yam farmers, approximately 95% (Table 2). Enugu had the highest population of farmers whose primary occupation was farming while Benue had the lowest. From the Table, it is obvious that there are many experienced yam producers in Nigeria. An average Nigerian yam farmer had farming experience of above 20 years. Ondo, Benue and Enugu farmers had mean farming experiences of 16, 22.9 and 23.2 years respectively. The majority of farmers in Nigeria had farming experience between 6-15 years (Table 2). There were more experienced yam farmers in Enugu than in other States. Enugu State had more farmers with farming experience of above 36 years. Nevertheless, the State had more farmers with less than six years farming experience. The results indicated that there was no significant difference in farming experience between Enugu and Benue States (see Table 1). Ondo yam farmers were less experienced in yam production. The study indicates that an average Nigerian yam farmer has a small farm. Yam producers in Nigeria had a mean farm size of 1.5 hectares (Table 1). Farm size was significantly different among regions. Benue had the largest farm size while Enugu had the lowest. The research discloses that Nigerian yam farmers have poor interaction with extension agents. An average Nigerian yam farmer has four extension visits per annum (Table 1). Ondo had more extension contact which was significantly different from other States. Extension is an important vehicle for agricultural technology dissemination. Increased access to extension services can be achieved through adequate funding of extension. The result of this investigation also shows that most Nigerian farmers are not members of agricultural organizations (Table 1). Approximately 38% of the yam producers were members of farming associations (where information on agriculture, particularly on production and marketing of yam were disseminated). Members also had information on input acquisition and discounts on inputs. More yam farmers in Ondo belonged to agricultural organizations. Membership of agricultural organization in Ondo was not significantly different from Benue. Enugu had few members of agricultural organizations, which was also similar to Benue State.

This research further reveals that most Nigerian yam farmers lack access to funds. Over 50 percent of Nigerian yam farmers lack access to credit for yam production (Table 1). Ondo State yam farmers have more access to funds than those in other States. Enugu yam farmers had less access to credit which is not significantly different from that of Benue. Financial institution should be located in close proximity to the farmers to increase farmers' access to fund. Awareness on credit acquisition by farmers should be created to inform them on how to obtain loans from financial institutions.

Finally, the socioeconomic analysis detects that Nigerian yam farmers are faced with some health issues. Approximately twenty two percent of the farmers had health challenges (Table 1). This was more severe in Benue and less in Ondo. The percentage of farmers in Ondo and Benue who had health challenges was similar. Establishment of health centres in these areas, and improvement in the conditions and management of the already existing ones will help improve the health conditions of farmers.

Yam production variables

Nigerian yam farmer produced approximately 12,743.44 tonnes of yam per annum on a 1.5 hectare land (Table 2). This implies that average on-farm yield of yam in Nigeria is about 8.5 tonnes. The largest yam output was recorded in Benue State. Enugu had the lowest yam output in Nigeria. There was a significant difference in yam production between States. Nevertheless, Benue State, which had the highest output, had the lowest yield. Ondo State had the highest yam yield, which is similar to Enugu. The volume of production obtained in Benue can be attributed to a large farm size among other factors rather than a high yam yield. The Table also indicates that Benue farmers have more access to land. The State had the highest mean farm size; this is followed by Ondo, then Enugu. An Average farmer in Benue, Ondo and Enugu had farm sizes of approximately 2, 1.4 and 1 hectare respectively. This research establishes that planting materials are more accessible in Benue than in other States. Benue yam farmers used more planting material than other States (Table 2). Enugu farmers had less access to planting material. The State used the lowest quantity of planting material for yam production. However, per hectare comparison of the quantity of planting material used for yam production indicated that Ondo used the highest quantity (Table 2). Ondo which used more planting material had the highest yam yield. This suggests that yam yield increases with the use of more planting material. This contradicts most studies on stocking density such as Mgbada *et al*. (2016) who reported an inverse relationship between the quantity of planting material and yield. It can be deduced from this result that planting material is crucial to increase yam productivity in Nigeria. Therefore, devising an effective distribution channel for seed yam in Nigeria, and adopting seed yam multiplication technique will improve the performance of yam farmers in Nigeria. The result reveals that the quantity of fertilizer use for yam production in Nigeria is low. Nigerian yam producers use insufficient fertilizer for yam production. On average, yam farmers in Nigeria used approximately 88kg of fertilizer (less than two bag of fertilizer) on a 1.5 hectare farm (Table 2). Enugu State used the highest

quantity of fertilizer (Table 2). An average Enugu yam farmer used more fertilizer (119.12kg). However, this value is below the fertilizer requirement for yam production in Nigeria (Agbaje and Aluko, 2009). Therefore, government should subsidize inputs, especially fertilizer, to increase its use for yam production. Nigerian yam production is largely non-mechanized (Author's observation, 2013). The farming system for yam production in Nigeria hinders successful mechanization (Opara 2003). This is because of the haphazard arrangement of crops and the use of much staking materials, which prevent easy movement through the farm (Authors observation, 2013). Therefore, farmers depend on manual labour for yam production. This evaluation shows that an average Nigerian yam farmer employs approximately 364 man-days of labour for yam production (Table 2). Benue State used more labour than other States. The lowest labour for yam production in Nigeria was used in Enugu State. Ondo employed more labour relative to farm size than the other States. This could imply that labour was over-utilized in the State or that yam production in Ondo State is more labour intensive. The development of a better farming system for yam in Nigeria would encourage mechanization and reduce the drudgery in yam production. This research recommends the development of an alternative farming system for yam production to encourage its mechanization in Nigeria. Yam farmers should be encouraged to use affordable labour-saving devices. Lastly, this investigation detects that Ondo farmers incur more cost on capital inputs than those of other States. Ondo, Benue and Enugu yam farmers spent N3055, N2871 and N1855 on capital inputs respectively. Despite Benue's large scale of production, an average yam farm in Benue used similar capital input as those in Ondo (Table 2). Ondo and Enugu had similar cost of capital input per hectare. This could imply over-utilization of capital input in Ondo and Enugu States. This differs from the findings of Izekor and Alufohia (2014) who observed an increasing return to scale of inputs in Edo State of Nigeria; indicating that input is being underutilized in the State. This investigation supports that Nigerian farmers employ inadequate inputs for yam production. Verter and Becvarova (2015) reported that insufficient inputs hinder yam production in developing countries including Nigeria.

Determinants of yam production in Nigeria

The Translog production function was used to evaluate yam production in Nigeria. The result of the Translog model indicates that similar variables influence yam output in Nigeria. Table 3 displays the MLE for yam in Nigeria and States respectively. It supports that farm size, quantity of planting material and labour are the significant determinants of yam output in Nigeria. The diagnostic statistics for all frontiers were significant except the variance ratio (γ) and LR test for Ondo. The result shows that farm size was significant in all the frontiers except in Ondo. It had positive coefficient in all the frontiers. This indicates increasing marginal productivity of farm size. Yam output increases with increase in farm size. This supports a priori expectation of increasing marginal productivity of farm size. It also confirms the findings of (Anyaegbunam *et al*., 2016; Mariano *et al*., 2010; Ohajianya *et al*., 2014; Alene and Hassan, 2003). As expected, farmers who had large farms produce more yams than those who have small ones. The magnitudes of the coefficients differ between frontiers. The magnitude of farm size was higher in Benue State. This indicates a higher output elasticity of farm size (responsiveness of output to change in farm size) in the State. Ondo State had the lowest coefficient of farm size, signifying a lower output elasticity of farm size in the State. Ondo had larger farms than Enugu (Table 2); however, there was more marginal productivity of farm size in Enugu than Ondo. This implies that Ondo can still increase the output considering the area of land it cultivates. It is essential for Nigerian yam farmers to increase their scale of production in order to boost yam production in the country. The Table also shows that doubling farm size would lead to further increase in its coefficient in Nigeria. Doubling farm size will further increase the output of yam in Nigeria. In the prevailing technology used for yam production in Nigeria, especially in Enugu and Ondo, farmers can double farm size. There would be more than proportionate increase in output with increase in farm size in Nigeria. Quantity of planting material influences yam output in Nigeria. Its coefficients were positive and significant in all the frontiers. This shows that increasing the quantity of planting material used for yam production would boost yam output in the country. This agrees with a priori expectation that there would be a marginal increase in output accruing from the additional planting material used. It is also in consonance with (Mariano *et al*., 2010) who observed a positive relationship between seed and rice output in the Philippines. The coefficient of planting material was highest in Ondo and lowest in Benue. This implies a more positive output response to increase in quantity of planting material in Ondo than in other States. The Table further illustrates that doubling the quantity of planting material in Nigeria and its States would lead to a further increase in its coefficient except in Ondo State. Farmers are advised to increase the quantity of planting material they use until MP = 0 (at the end of stage two of production) for output maximization. Nonetheless, it is more economical to produce at the point of optimal scale. Yam production in Nigeria is limited by unavailability and high cost of planting material (Amaefula *et al*., 2018). Farmers usually sell their seed yams after satisfying their consumption needs (Asumugha *et al*., 2009). Although seed yam specialists now exist in Nigeria, supply through this source is minimal (Phillips *et al*., 2013). Unfortunately, farmers often use low quality planting materials obtain from their own farm (Amaefula *et al*., 2018). The use of planting material from previous harvests will lead to a build-up of disease-causing organisms and reduction in yield (IITA, 2009b). Provision of clean planting material for yam production and adoption of yam multiplication techniques such as yam minisett technology will boost yam production in Nigeria. The

result supports that labour is a significant variable influencing yam output in all frontiers except in Benue. It had positive coefficients in all the frontiers; implying that output increases with the use of more labour for yam production. This supports the findings of Backman *et al*. (2011). This investigation contradicts Ashagidigbi *et al*. (2011); Alene and Hassan (2003) and Amaefula *et al*. (2009) who reported a negative correlation between labour and production. There was increasing marginal productivity of labour in Nigeria. More output response to change in labour was observed in Ondo State. Labour is essential for output maximization. The Table further reveals that doubling labour would lead to a more than proportionate increase in output in Ondo. This supports the idea that it is crucial to increase labour to boost yam production in the State. Farmers are underutilizing labour in Nigeria, particularly in Ondo. Underutilization of labour could be as a result of unavailability of work-force or high cost of labour in the rural areas, which prevent farmers from employing sufficient labour for yam production. Farmers are advised to employ more labour for yam production. Those in Ondo can double labour used for yam production. Labour could be augmented with labour-saving devices. Farmers could use simple and affordable machinery for yam production to improve their performance. The Table shows that Ondo State had the highest variation in output due to inefficiency. The variance ratio, gamma (γ) depicts the variation in output that is due to inefficiency. The coefficient of variance ratio was highest in Ondo State (0.97). This indicates that 97% of the total variation in output was due to inefficiency in Ondo. Benue had the lowest variance ratio (0.78), meaning that 78% of the total variation in output in Benue State was due to inefficiency.

Elasticity and return to scale of input use for yam production

The investigation of the elasticity and return to scale of yam production reveals that Nigerian yam farmers are experiencing decreasing return to scale except those in Enugu State. Table 4 presents elasticities and return to scale of yam production. As earlier stated, the first order derivatives of the Translog production function are the elasticities at sample mean (data were mean corrected to zero). The sum of the first order parameters is the return to scale (Coelli *et al*., 2005). From the result, yam farmers in Enugu State are experiencing increasing return to scale. This is in line with the findings of Izekor and Alufohia (2014) who observed an increasing return to scale of yam production in Edo State. The use of more input led to a more than proportionate increase in output in Enugu State. The result shows that there is a high output response to farm size in Nigeria, especially in Enugu and Benue. There is increasing marginal productivity of farm labour in Nigeria. Labour has the highest output elasticity in Ondo. This indicates that labour is the most valuable input for yam production in the State. Labour is underutilized in Nigeria, particularly in Ondo. Izekor and Alufohia (2014) observed an increasing return to scale of inputs in Edo State, Nigeria; indicating that they are underutilized in the State. Government subsidy on inputs will improve the performance of yam farmers in Nigeria.

Conclusion

In conclusion, this research has shown that Nigerian yam farmers use insufficient inputs for yam production. Therefore, government subsidy on inputs, especially on planting material and fertilizer will boost yam production in Nigeria. This study has also proved that yam output increased with farm size in Nigeria. However, an average Nigerian yam farmer had small farm size. Farmers in Nigeria are encouraged to increase their farm size. Nigerian land reform policy should aim at redistributing lands to farmers to enable them increase land area under yam production. The findings of this investigation suggest that labour is underutilized in Nigeria, particularly in Ondo State. Labour increases yam output in Nigeria. However, labour is expensive relative to farmer income in the country and usually unavailable when required. Therefore, affordable labour-saving devices such as cheap machinery should be used for yam production in Nigeria. This study has established that planting material is an increasing factor of output. Farmers in Nigeria have to use more planting material to boost yam production and improve their efficiency. They should purchase planting materials from reliable sources. Research institutes and Agricultural Development Projects should adopt appropriate input dissemination strategies to ensure that planting materials reach yam farmers in good condition and time.

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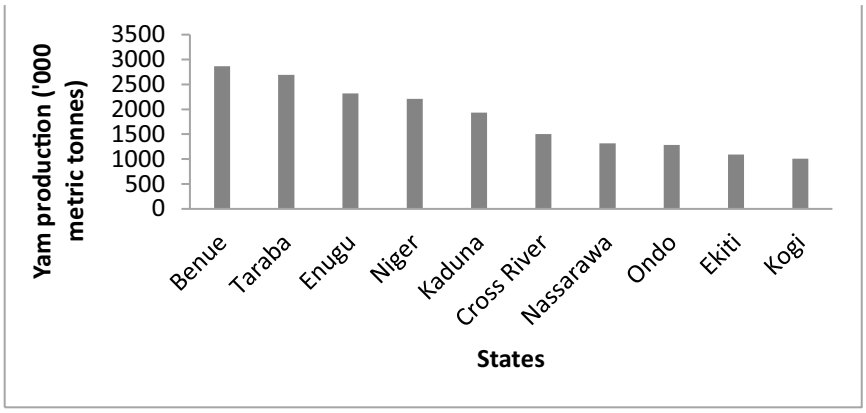

Figure 1: Top yam-producing States of Nigeria
Source of data: (Open Data for Africa, 2015)

Table 1: Socioeconomic characteristics of yam farmers in Nigeria

Variables	Nigeria	Benue	Enugu	Ondo
Average age (years)	47.2	45.0[b]	52.0[a]	44.7[b]
Gender (% of male farmers)	85.0	88.3[a]	79.2[b]	87.5[ab]
Average household size (number of household members)	8.2	10.8[a]	7.5[b]	6.4[b]
Average education (years)	9.3	9.6[a]	7.8[b]	10.4[a]
Average farming experience (years)	20.7	22.9[a]	23.2[a]	16.0[b]
Average farm size (hectare)	1.5	2.2[a]	0.9[c]	1.4[b]
Extension visit (number of times)	4.1	3.7[b]	2.1[b]	6.5[a]
Member of Organization (%)	37.8	38.3[ab]	27.5 [b]	47.5 [a]
Access to credit (%)	46.9	45.0[b]	44.2[b]	51.7 [a]
Health issues (%)	21.9	32.5 [a]	21.7[b]	11.7[b]

Source: Field Survey, 2013
Note: a,b,c letters denote significant differences (at 0.05 level) in variables across regions in a descending order of magnitude. Variables with the same superscript are similar

Table 2: Differences in production variables across regions

Variables	Nigeria	Enugu	Ondo	Benue
Variables per farm				
Output (kg)	14796.94	9771.80[c]	14467.58[b]	20151.44[a]
Farm size (ha)	1.51	0.90[c]	1.41[b]	2.22[a]
Planting material (kg)	2301.76	1374.33[c]	2013.42[b]	3517.53[a]
Fertilizer (kg)	88.17	119.11[a]	36.18[b]	109.23[a]
Labour (Man-days)	363.76	181.97[c]	393.10[b]	516.19[a]
Capital input (depreciated cost, ₦)	2593.40	1854.71[b]	3054.91[a]	2870.59[a]
Variables per hectare				
Yield kg/ha	12,743.44	12945.71[a]	14235.97[a]	11048.64 [b]
Planting material (kg/ha)	2259.54	1996.91[b]	2725.24[a]	2056.48 [b]
Fertilizer kg/ha	104.19	220.41[a]	34.46[b]	57.71[b]
Labour (Man-days/ha)	263.23	257.66[b]	292.43[a]	239.61 [b]
Capital input (N/ha)	3195.60	3974.89[a]	3936.96[a]	1675.83 [b]

Source: Field Survey, 2013
Note: a,b,c letters denote significant differences (at 0.05 level) in variables across regions in a descending order of magnitude. Variables with the same superscript are similar

Table 3: Maximum Likelihood Estimates of Translog production function for yam in Nigeria

Production Factors	Parameters	Nigeria	Benue	Enugu	Ondo
Constant term	b_0	0.039**	0.076*	0.12	0.11
		(0.050)	(0.048)	(0.11)	(0.33)
Farm size	b_1	0.49***	0.56***	0.52***	0.11
		(0.057)	(0.14)	(0.10)	(0.14)
Planting material	b_2	0.12***	0.090**	0.11**	0.18***
		(0.026)	(0.048)	(0.050)	(0.072)
Fertilizer	b_3	0.014	0.034	0.036	0.0045
		(0.011)	(0.039)	(0.031)	(0.029)
Labour	b_4	0.25***	0.093	0.23***	0.55***
		(0.054)	(0.13)	(0.068)	(0.15)
Capital input	b_5	-0.015	0.047	0.11	-0.035
		(0.035)	(0.060)	(0.11)	(0.069)
Farm size^2	b_6	1.16***	0.38	1.01***	3.97*
		(0.25)	(2.04)	(0.40)	(2.55)
Planting material^2	b_7	0.19***	0.42***	0.17	-0.01
		(0.080)	(0.14)	(0.17)	(0.55)
Fertilizer^2	b_8	0.0076	0.0077	0.013	0.012
		(0.0068)	(0.012)	(0.013)	(0.023)
Labour^2	b_9	0.14*	-0.83	0.11	6.30***
		(0.10)	(1.50)	(0.16)	(1.02)
Capital input^2	b_{10}	0.14	0.69 *	-0.16	-0.33
		(0.18)	(0.47)	(0.66)	(0.31)
Farm size*planting material	b_{11}	-0.39***	-0.79*	-0.31**	0.66
		(0.10)	(0.50)	(0.16)	(0.54)
Farm size *fertilizer	b_{12}	-0.0053	0.033	0.0058	0.073
		(0.011)	(0.11)	(0.029)	(0.13)
Farm size *labour	b_{13}	-0.63***	0.21	-0.67***	-5.20***
		(0.13)	(1.61)	(0.19)	(1.37)
Farm size *capital input	b_{14}	0.052	-1.22**	0.42	0.50
		(0.16)	(0.70)	(0.36)	(0.62)
Planting material * fertilizer	b_{15}	-0.0067	0.013	-0.025*	-0.021
		(0.0062)	(0.018)	(0.017)	(0.018)
Planting material * labour	b_{16}	0.20***	0.50	0.23**	-0.68**
		(0.074)	(0.44)	(0.11)	(0.32)
Planting material *capital input	b_{17}	-0.11*	-0.12	-0.44**	-0.14
		(0.080)	(0.24)	(0.23)	(0.27)
Fertilizer* labour	b_{18}	0.0027	-0.020	0.0014	-0.089
		(0.0098)	(0.10)	(0.016)	(0.14)
Fertilizer*capital input	b_{19}	0.017**	-0.031	0.0082	0.023**
		(0.0095)	(0.040)	(0.035)	(0.013)
Labour*capital input	b_{20}	0.0019	1.16**	0.21	-0.30
		(0.14)	(0.59)	(0.22)	(0.71)
Diagnostic Statistic	σ^2	0.053***	0.026***	0.10***	0.047
Sigma – squared		(0.0071)	(0.0071)	(0.027)	(0.038)
Gamma	γ	0.81***	0.78***	0.91***	0.97***
		(0.066)	(0.16)	(0.10)	(0.28)
Log likelihood function		152.72***	92.06***	28.54***	80.95***
LR		15.20***	1.98**	6.80***	6.64***

Source: Frontier 4.1 results, 2015

The estimated standard errors are given in parentheses correct to two-significant digits. The coefficient estimates are given to the same number of digits

******, ** and *are significant at 1, 5 and 10% respectively. Standard Errors are given in parentheses***

Table 4: Elasticity and return to scale of yam production

Production Inputs	Nigeria	Benue	Enugu	Ondo
Farm size	0.49	0.68	0.52	0.11
Planting material	0.12	0.04	0.11	0.17
Fertilizer	0.01	0.03	0.04	0.00
Labour	0.25	0.02	0.23	0.55
Capital input	-0.01	0.02	0.11	-0.03
Return to scale	0.86	0.76	1.01	0.80

Source: Frontier 4.1 results, 2015